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ABSTRACT

Being open to new ideas is instrumental for the professional development of teachers. Using numerous case studies of prospective teachers' beliefs as a backdrop, this study investigated the tensions and struggles four prospective teachers encountered as they confronted the unfamiliar. Both the formation of their belief systems and the interactions of their beliefs with the unfamiliar were interpreted as participants engaged in a discussion-, reflection-, and activity-rich proactive teacher education environment. Through the tensions and struggles associated with multiple interpretations of mathematics and issues related to multiculturalism, insights were gained into the complexities of becoming a teacher during this time of mathematics education reform. (Author/MKR)

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Bridget Arvold and Maureen Albright

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(17th PME-NA, Columbus, OH, October 21-24, 1995)

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TENSIONS AND STRUGGLES: PROSPECTIVE SECONDARY MATHEMATICS TEACHERS CONFRONTING THE UNFAMILIAR

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Being open to new ideas is instrumental for the professional development of teachers. Using numerous case studies of prospective teachers' beliefs as a backdrop, we investigated the tensions and struggles four prospective teachers encountered as they confronted the unfamiliar. We interpreted both the formation of their belief systems and the interactions of their beliefs with the unfamiliar as our participants engaged in a discussion, reflection, and activity-rich pro-active teacher education environment. Through the tensions and struggles associated with multiple interpretations of mathematics and issues related to multiculturalism, we gained insights into the complexities of becoming a teacher during this time of mathematics education reform.

In light of recent reform efforts in mathematics education, teachers and teacher educators are striving to extend their own reflective, analytic, and adaptive mind sets and to encourage others to do so as well. Such mind sets are necessary to help teachers create a rich, comfortable, and empowering environment for their students (NCTM, 1991). Discussions, reflective journal writing, and experiencing learning and teaching through new methods provide opportunities for opening minds to new ideas (NCTM, 1989).

The manner in which people address new ideas is complex. One contributing factor in this process is the individual's tendency toward open-mindedness, a putting aside of predispositions and forestalling premature judgment in an attempt to come to understand new ideas and new perspectives of familiar ideas. Although existing beliefs and knowledge influence an individual's ability to attend to new ideas and understand them, existing beliefs can also inhibit one's intellectual growth. Since many teachers and prospective teachers can profit from gaining a broader range of perspectives, being open to new ideas is instrumental in their professional growth.

As part of the RADIATE[1] research team, we investigated the tensions and struggles of prospective secondary mathematics teachers participating in a proactive teacher education program. The program shared the underlying philosophies expressed in the NCTM *Standards* (1989, 1991). Paramount was the philosophy that educating is not disseminating information but facilitating each individual's accommodation of existing knowledge to new ideas within the context of a social setting. Reflection upon multiple perspectives of mathematics,

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teaching, and learning permeated the environment. Although the program's curricular design was responsive to student needs, the sharing of multiple perspectives was fundamental to all course activities.

Framework

Multiple lenses provided insights into the beliefs and tensions of the prospective teachers. The dynamics of the belief systems in terms of strength of psychological commitment and clustering of beliefs (Green, 1971) aided us in identifying and interpreting the nature of the prospective teachers' beliefs. Within these systems, the received and connected procedural ways of knowing (Belenky, Clinchy, Goldberger, & Tarule, 1986) and the progression from dualism to relativism (Perry, 1970) provided insights into how beliefs and knowledge were held and into the sense of ownership related to specific beliefs. As tensions arose, the idea of a continuum from close-mindedness to open-mindedness (Rokeach, 1960) provided insights into how our prospective teachers handled these tensions, and the degree to which they chose to ignore the unfamiliar or to keep their minds open as they struggled with new ideas.

Methodology

The present study, as part of the RADIATE project, involved 15 prospective teachers with whom we worked from April 1994 through June 1995. Data were collected during the prospective teachers' participation in specially designed classes integrating pedagogy and content, during their student teaching experiences and during the culminating education seminar. Participant data were collected through initial surveys, nine guided interviews, handwritten and electronic journals, classroom and field observations and appropriate artifacts such as tests and reports. The instructor's January statement of goals and concerns supplemented the data from the participants. All members of the seven-person researcher team shared their respective constant comparative analyses (Glaser-Straus, 1967) during weekly discussions. In our analysis of tensions and struggles arising from encounters with the unfamiliar, we first categorized data contributed by the entire team. In this report we used a theoretical sampling (Glaser-Straus, 1967) to focus on the unfamiliar Standards-driven encounters most often noted by the prospective teachers. We explicitly discuss the tensions and struggles precipitated by the multiplistic-oriented functions unit and a multi-cultural lesson. Since the studies of our own particular participants provided somewhat representative data, we focused our attention on the tensions and struggles of Harriet, Carl, Alice, and Shannon.

Tensions and Struggles

The prospective teachers' cookbook expectations of the program contrasted greatly with the design of the curriculum and the instructor's stated goals "to shake people up and challenge them to think beyond the surface. I want them to become reflective about their assumptions, their reasoning, and their behaviors ...While I want students to be comfortable and to learn in a friendly, open environ-

ment, rattling ideas takes priority over comfort." Our participants entered this unfamiliar classroom environment with varied backgrounds. After losing interest in "boring" accounting, Harriet entered the teaching program to become a certified secondary mathematics teacher. She believed she had already learned all she needed to know from her mother, an experienced middle school mathematics teacher. It was her mother's voice she shared with us. Carl shared a different voice of experience. It was after fourteen years in a managerial workforce that he sought an undergraduate degree and teacher certification. His volunteer mathematics tutoring of confused student employees and his caring nature piqued his interest in improving the teaching profession by joining its ranks. Carl believed field experiences would be his teacher. Unlike Harriet and Carl, Alice had always wanted to teach. Her early practicum experience gave rise to both her dissatisfaction with traditional teaching techniques and a multitude of questions about the process of teaching. She hoped for an inspiring learning experience. Lacking a vision of her future, Shannon seriously considered the recommendations of her high school teachers, and entered a teacher education program. Like Alice, once Shannon realized that there were alternatives to lecturing, she poised herself to "listen and digest" as she encountered "the whole Standards outlook on things."

Material on functions served as an introduction to the program. Besides providing an opportunity to integrate the learning of content and pedagogy, the material fit the instructor's stated goal of helping "students realize that there is a great deal of high school mathematics that they do not know." The functions material built upon multiple strategies for problem solving by scaffolding activities that included investigations of multiple representations and categorizations of functions, analysis of case studies and reflections on pedagogical issues. Most often the activities included the modeling of real life situations and follow-up analyses enriched by the use of graphing calculators, and algebraic, geometric, and spreadsheet computer software.

Perceiving the function material as irrelevant, Harriet's tensions were limited to her coping with the curriculum. "It was like what we saw and what we are going to see is going to be much higher than what high school students are going to see which means it was like it was there for our enjoyment and completely almost forgot about our students." Harriet placed herself in the teacher role as she spoke of "our" students but her product-oriented mathematics blinded her of the opportunity to gain a deeper understanding of mathematics and teaching. Her more dualistic orientation (Perry, 1970) inhibited her seeing the value of multiple perspectives. Carl viewed the activities involving multiple strategies and multiple perspectives as no more than a catalogue of activities for use in the classroom. Carl's orientation toward partitioning his beliefs and knowledge (Green, 1971) instead of making connections was evident in almost every aspect of our study. For example, Carl's failure to understand the derivative nature of multiplication and addition during a lesson on completing the square precipitated tension during his student teaching. When he finally realized that his student's "2 times 13/2" meant the same as his "13/2 plus 13/2," he did not contemplate his negative response to his student, but rather was irritated at not having been told him about this

fact in his earlier education. He claimed no ownership of his mathematics. After a brief troublesome period contemplating how he might fill the gaps in his mathematical knowledge, his pride in a high score on the state teachers' exam eased his tension. This instance reflected how his strong psychological beliefs (Green, 1971) held from a dualistic perspective (Perry, 1970) supported his abandonment of tension and struggle. The dualistic tendencies of both Harriet and Carl forestalled most tensions and obstructed not only the relevance of pedagogical issues but an analysis of the multiplistic and connected nature of the rich mathematics.

Both Alice and Shannon entered the program confident in the richness of their mathematics only to become perplexed by the function-related activities. Alice expressed dissatisfaction with the recurrent discussions of the maximum volume box problem while Shannon struggled to become proficient with the unfamiliar technology, trusting that soon the purpose for all this mathematics in a "methods class" would be explained. Although the experiences with the functions material did not conflict directly with their knowledge of mathematics, it underscored an unrecognized perspective of mathematics. Although neither Alice nor Shannon came to understand mathematics as one's own construction, upon reflection each of them came to recognize the lack of depth in their own received (Belenky et al., 1986) mathematical knowledge. Even though Shannon expressed her newfound freedom in mathematics, "I like stumbling around with math ... experimenting and playing around," she and Alice struggled with these new disconnected pieces of mathematics. Later Alice and Shannon credited the subsequent study of the Standards and their research involvement for helping them gain a perspective on what they had been experiencing. Their understanding of the philosophy of the Standards added coherence to the multiple ideas precipitated by the functions material by uniting many of the belief clusters (Green, 1971) that they had been forming.

Both the functions material and aspects of the multi-cultural lesson permeated the entire program. The multi-cultural lessons were driven by readings and discussions using the prospective teachers' own interpretations of culture. Harriet welcomed the study of culture even though she, as an African-American, had "not learned a whole lot" in class. She was already "aware and experienced" in cultural issues. She was comfortable with most cultural issues because they substantiated the knowledge imparted upon her by her select group of authority figures, her received knowledge (Belenky, 1986). There was one particular reading and classroom discussion that incited her to question and ultimately modify her belief about color-blindness. "I have come to realize that color-blindness is not a very powerful or profitable approach to relating to other people [students]." Her reflective re-evaluation of an existing belief illustrated an infrequently observed move toward open-mindedness (Rokeach, 1960) in an area of deep psychological commitment (Green, 1971).

Harriet did not adapt her existing perception of culture as race to the context of the mathematics classroom, and Carl's perception of culture as the origins of mathematics remained void of the new context as well. Harriet and Carl each protected their existing beliefs from contamination, a more dualistic orientation (Perry, 1970). Carl hinted at why he dismissed the relevance of culture. "I'd have

a difficult time right now focusing on multi-cultural because there's so many other things ... Yes, it's something I'd like to master but certainly would not go into my initial teaching methods. ... Multi-cultural was just thrown in because an instructor wanted it, [but] I did use an aspect of it when it just happened to come up." Culture became just another disconnected belief cluster (Green, 1971), another item on his list of things to "master."

Alice's initial tension also reflected her limited view of culture in mathematics. "Math is math. Culture doesn't change the way you do math." Shortly thereafter she widened her perspective of mathematics as process and reflected upon the influence of culture in the creation of mathematics. Widening again, she reflected upon the cultures of her students. Alice and Shannon each struggled with similar issues as they came to the realization that their inability to observe culture during field observations was due in part to their negative view of "labeling people." In their struggles to integrate conflicting ideas, they reflected a more relativistic orientation (Perry, 1970). Alice chose to unveil her struggles in addressing the needs of her non-English speaking student through her senior research project, and evidenced an area of initial commitment (Perry, 1970) in her growing concern that many teachers are unaware and insensitive to the cultures of their students. Shannon focused on the importance of treating "any student with respect, no matter if their views are different," and "the teacher's responsibility to make sure students do not put down other students for their differences." She valued students gaining a better understanding of mathematics through its historical context and contemplated culturally rich research projects. Alice and Shannon both attempted to incorporate the voice of the student into their more connected procedural knowing (Belenky et al., 1986).

As we focused our analysis on tensions arising from encounters with new ideas, we tended to neglect analysis of how these new ideas actually relieved existing tensions. As existing tensions diminished others took their place. Alice's tensions relating to the inadequacies of traditional teaching lessened as she struggled to create a new vision of teaching. Shannon's tensions eased as she discovered that learning mathematics need not be constrained to the formalist rigor she had come to previously accept. Carl focused his tensions associated with his desire to improve the teaching profession as he concentrated on cooperative learning as his solution to poor teaching. Harriet entered with few tensions and left the program still questioning the appropriateness of the program itself.

Summary

This study suggests that our prospective teachers' orientations toward tensions were directly related to their inferred belief systems. More dualistic orientations tended to ward off tension whereas more relativistic orientations allowed the consideration of multiple perspectives. A more relativistic orientation also nurtured struggles involving analysis and the integration of novel ideas. In belief systems with an plethora of belief clusters, new ideas remained segregated from existing beliefs or entered a single cluster instead of becoming connectors be-

tween clusters. The abundance of multiplicity in the program may have created too much interference for viable attending and connecting.

Discussion

We as researchers, must open our minds to new ideas and new perspectives in order to better understand our prospective teachers and help them learn. Our own limited domains trammeled our analysis of the complexity of the dynamic environment. Although we gained a better understanding of how existing belief systems, tensions and struggles influence the professional growth of teachers, care must be taken to account for the value of theoretical perspectives in order not to fall into the trap of what Bauersfeld (1988) refers to as "theoretical autism."

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